

Resource Materials

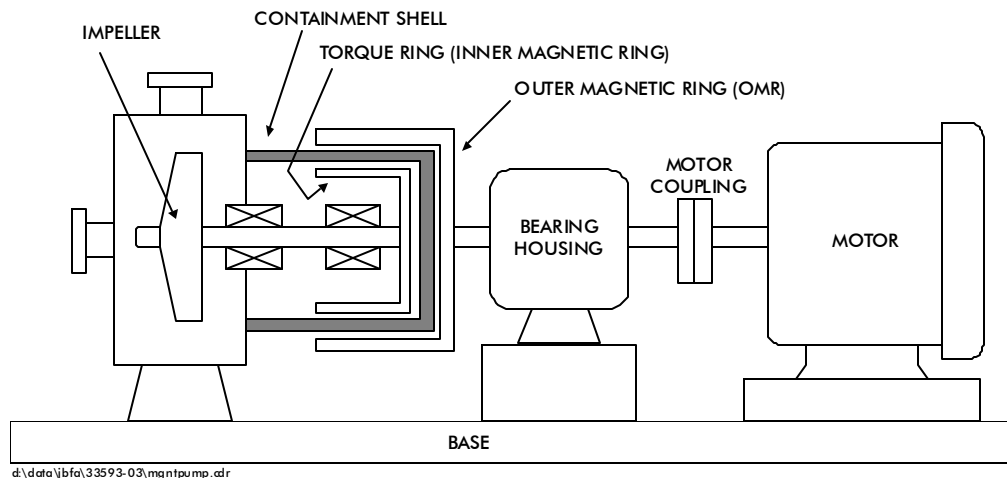
Further Information on Decision Analysis Tools (with examples)

Application of the Plurality Voting Method

Problem Identification

You are leading a project team that is consulting on the preliminary design of a new Outer Continental Shelf (OCS) platform for deployment in the Gulf of Mexico.

In the conceptual design, the plans call for scrubbers (i.e., knockout drums) upstream of both the 1st and 2nd stages of the gas compressor to help prevent entrained liquids (i.e., hydrocarbons and produced water) in the gas from entering the compressor, where the liquids could damage the compressor. The plans for the new platform call for a pump to return the liquids that accumulate in the scrubbers to the 1st stage separator (i.e., the vessel that separates the water produced, the oil, and the gas as it flows from the riser to the platform). However, the plans do not specify the type of pump. You must help the company decide what type of pump is best suited for this application.



Competing Alternative Specification

Based upon your and the project team's previous experiences with similar applications, you consider two types of pumps for this application:

- Canned pump – a centrifugal-type pump that uses a hermetically sealed space to confine the contents of the pump, minimizing the risk of material releases by eliminating the need for mechanical-type seals (see figure)
- Standard centrifugal pump – a centrifugal pump (vertical or horizontal orientation) that uses a single mechanical seal to prevent the contents of the pump from leaking at the pump

In the project team's judgment, either type of pump will meet the service requirements and standards for this application. Previous experience has shown that the centrifugal pump is the least expensive to purchase, but is prone to more failures (especially seal failures) requiring downtime for maintenance and involving dangerous releases of hydrocarbons. The canned pump is more expensive to purchase and repair, but is less prone to failure. Maintenance technicians generally prefer the standard centrifugal pump because these pumps are easier to repair and are much more common than canned pumps, making spare parts more readily available. Also, most technicians are more knowledgeable about centrifugal pumps.

Values Assigned for Each Factor/Subfactor for Each Type of Pump

Factor	Subfactor (if any)	Values for each type of pump – Best estimate
Cost (\$)	Initial – canned – standard centrifugal Maintenance – canned – standard centrifugal	1900 900 400 500
Safety risk (% chance of a significant event over 5 years) – canned – standard centrifugal	None	.1 1
Environmental risk (% chance of a significant event over 5 years) – canned – standard centrifugal	None	.3 3
Maintenance training needs (hours) – canned – standard centrifugal	None	4-8 hr 0 hr
Operational outage (hours)	Spare part acquisition – canned – standard centrifugal Actual repair – canned – standard centrifugal	2 hr ~.5 hr 4 hr 1 hr

Results of the Plurality Method





Pump	Cost		Safety Risk	Environmental Risk	Maintenance Training Needs	Operational Outage		Number of First Place Votes
	Initial	Maintenance				Spare Parts Acquisition	Actual Repair	
Canned	2	1	1	1	2	2	2	3
Centrifugal	1	2	2	2	1	1	1	4

Using the plurality method, the centrifugal pump would be chosen. It is important to note that if safety and environmental factors were weighted higher than economic factors, the canned pump would be chosen.

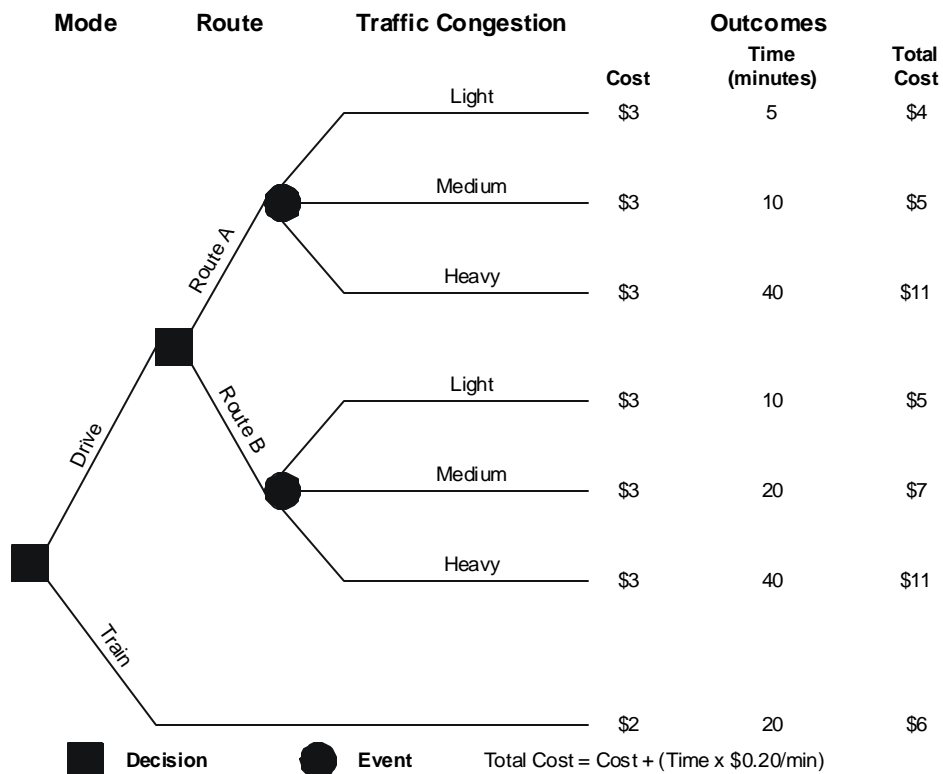
Application of the Decision Tree Method

Problem 1: What is the best way to get to work?

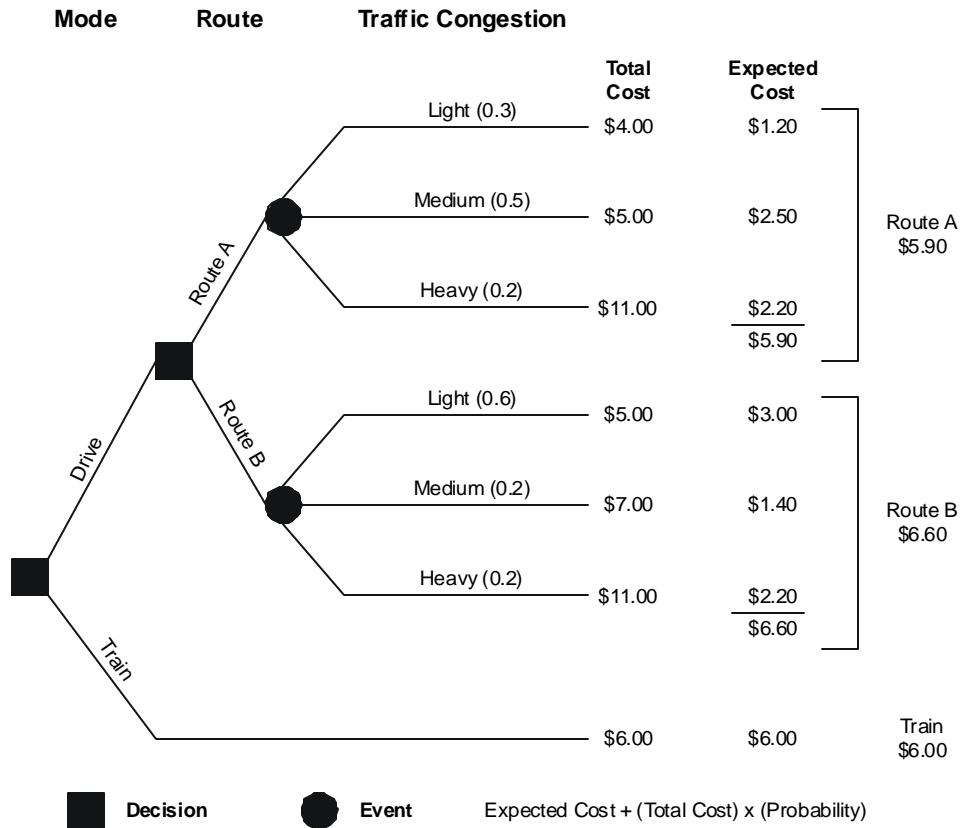
Below is a graphical representation of the decision and possible outcomes.

Decision	Alternatives	Uncertainties	Outcomes	Values	Utility
How should I get to work tomorrow?	Transportation Mode	Traffic Congestion	Prob.	Commute Time	 Total Cost  U (total cost)
	Drive	Light	0.3		
	Route A	Medium	0.2	Commute Cost	
	Route B	Heavy	0.5		
	Ride the Train				

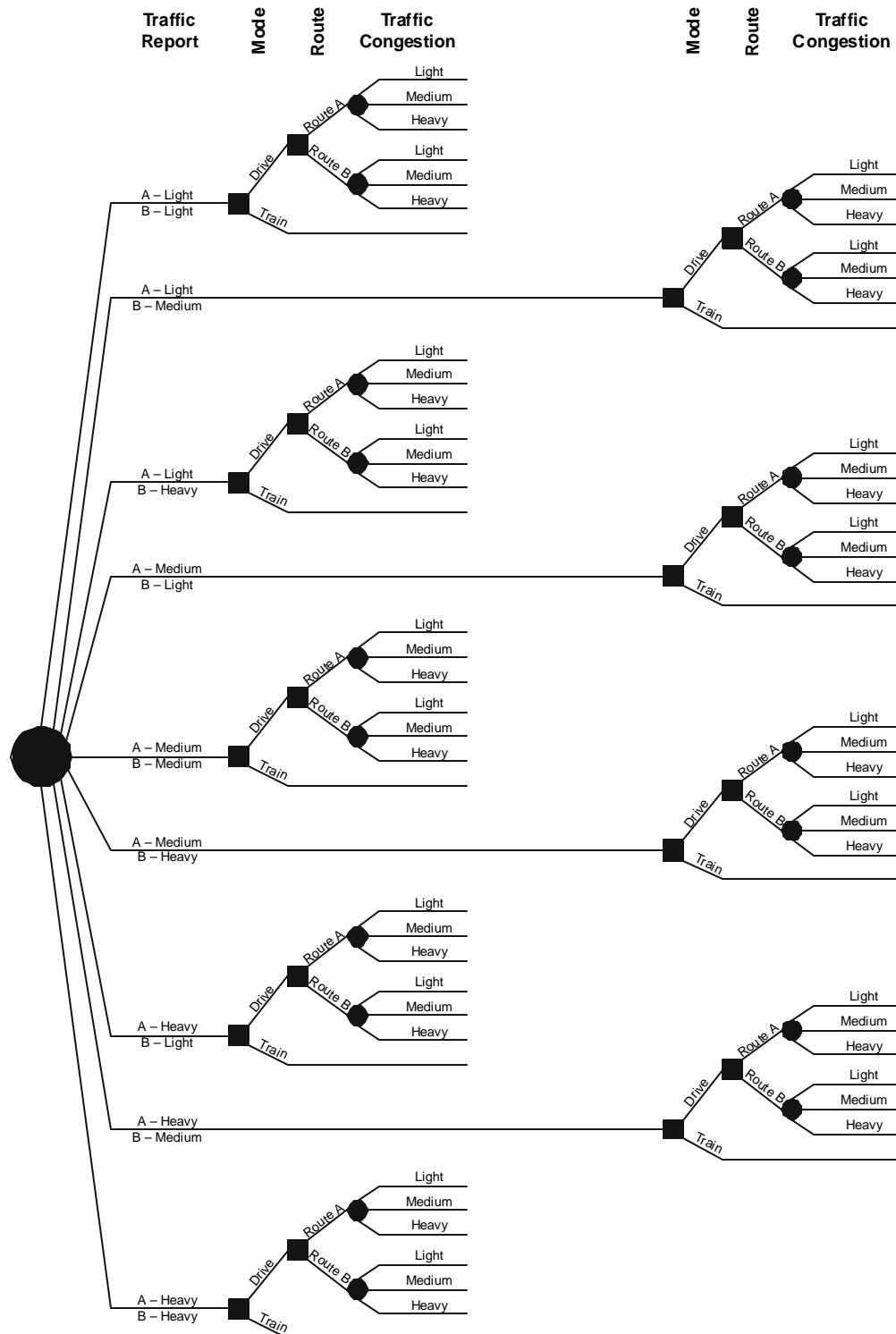
First, calculate the cost (or total cost of each possible outcome.



Next, calculate the expected cost of each outcome and the total expected cost of each alternative (route).



If desired, multiple events can be analyzed and chained together. The case below considers the traffic report (which could be in error) for each driving alternative. The resulting decision tree would look like the one below. The tables on the following pages calculate the expected values of the alternatives.



Traffic Report						Cost					
A	B	Mode	Route	Actual Congestion	Listen to Traffic Report	Travel Time	Parking/ Fare	Time	Total Cost	Probability	Expected Cost
Light	Light	Drive	A	Light	5	5	\$3.00	\$2.00	\$5.00	0.90	\$4.50
		Drive	A	Medium	5	10	\$3.00	\$3.00	\$6.00	0.00	\$0.00
		Drive	A	Heavy	5	40	\$3.00	\$9.00	\$12.00	0.10	\$1.20
		Drive	B	Light	5	10	\$3.00	\$3.00	\$6.00	0.90	\$5.40
		Drive	B	Medium	5	20	\$3.00	\$5.00	\$8.00	0.00	\$0.00
		Drive	B	Heavy	5	40	\$3.00	\$9.00	\$12.00	0.10	\$1.20
		Train			5	20	\$2.00	\$5.00	\$7.00	1.00	\$7.00
											\$7.00
Light	Medium	Drive	A	Light	5	5	\$3.00	\$2.00	\$5.00	0.90	\$4.50
		Drive	A	Medium	5	10	\$3.00	\$3.00	\$6.00	0.00	\$0.00
		Drive	A	Heavy	5	40	\$3.00	\$9.00	\$12.00	0.10	\$1.20
		Drive	B	Light	5	10	\$3.00	\$3.00	\$6.00	0.10	\$0.60
		Drive	B	Medium	5	20	\$3.00	\$5.00	\$8.00	0.80	\$6.40
		Drive	B	Heavy	5	40	\$3.00	\$9.00	\$12.00	0.10	\$1.20
		Train			5	20	\$2.00	\$5.00	\$7.00	1.00	\$7.00
											\$7.00
Light	Heavy	Drive	A	Light	5	5	\$3.00	\$2.00	\$5.00	0.90	\$4.50
		Drive	A	Medium	5	10	\$3.00	\$3.00	\$6.00	0.00	\$0.00
		Drive	A	Heavy	5	40	\$3.00	\$9.00	\$12.00	0.10	\$1.20
		Drive	B	Light	5	10	\$3.00	\$3.00	\$6.00	0.00	\$0.00
		Drive	B	Medium	5	20	\$3.00	\$5.00	\$8.00	0.15	\$1.20
		Drive	B	Heavy	5	40	\$3.00	\$9.00	\$12.00	0.85	\$10.20
		Train			5	20	\$2.00	\$5.00	\$7.00	1.00	\$7.00
											\$7.00
Medium	Light	Drive	A	Light	5	5	\$3.00	\$2.00	\$5.00	0.15	\$0.75
		Drive	A	Medium	5	10	\$3.00	\$3.00	\$6.00	0.70	\$4.20
		Drive	A	Heavy	5	40	\$3.00	\$9.00	\$12.00	0.15	\$1.80
		Drive	B	Light	5	10	\$3.00	\$3.00	\$6.00	0.90	\$5.40
		Drive	B	Medium	5	20	\$3.00	\$5.00	\$8.00	0.00	\$0.00
		Drive	B	Heavy	5	40	\$3.00	\$9.00	\$12.00	0.10	\$1.20
		Train			5	20	\$2.00	\$5.00	\$7.00	1.00	\$7.00
											\$7.00
Medium	Medium	Drive	A	Light	5	5	\$3.00	\$2.00	\$5.00	0.15	\$0.75
		Drive	A	Medium	5	10	\$3.00	\$3.00	\$6.00	0.70	\$4.20
		Drive	A	Heavy	5	40	\$3.00	\$9.00	\$12.00	0.15	\$1.80
		Drive	B	Light	5	10	\$3.00	\$3.00	\$6.00	0.10	\$0.60
		Drive	B	Medium	5	20	\$3.00	\$5.00	\$8.00	0.80	\$6.40
		Drive	B	Heavy	5	40	\$3.00	\$9.00	\$12.00	0.10	\$1.20
		Train			5	20	\$2.00	\$5.00	\$7.00	1.00	\$7.00
											\$7.00

Traffic Report							Cost							
A	B	Mode	Route	Listen to			Parking/ Fare		Total Cost		Probability		Expected Cost	
				Actual	Traffic	Travel								
				Congestion	Report	Time								
Medium	Heavy	Drive	A	Light	5	5	\$3.00	\$2.00	\$5.00	0.15	\$0.75			
		Drive	A	Medium	5	10	\$3.00	\$3.00	\$6.00	0.70	\$4.20		\$6.75	
		Drive	A	Heavy	5	40	\$3.00	\$9.00	\$12.00	0.15	\$1.80			
		Drive	B	Light	5	10	\$3.00	\$3.00	\$6.00	0.00	\$0.00			
		Drive	B	Medium	5	20	\$3.00	\$5.00	\$8.00	0.15	\$1.20		\$11.40	
		Drive	B	Heavy	5	40	\$3.00	\$9.00	\$12.00	0.85	\$10.20			
		Train		5	20	\$2.00	\$5.00	\$7.00	1.00	\$7.00		\$7.00		
Heavy	Light	Drive	A	Light	5	5	\$3.00	\$2.00	\$5.00	0.00	\$0.00			
		Drive	A	Medium	5	10	\$3.00	\$3.00	\$6.00	0.20	\$1.20		\$10.80	
		Drive	A	Heavy	5	40	\$3.00	\$9.00	\$12.00	0.80	\$9.60			
		Drive	B	Light	5	10	\$3.00	\$3.00	\$6.00	0.90	\$5.40			
		Drive	B	Medium	5	20	\$3.00	\$5.00	\$8.00	0.00	\$0.00		\$6.60	
		Drive	B	Heavy	5	40	\$3.00	\$9.00	\$12.00	0.10	\$1.20			
		Train		5	20	\$2.00	\$5.00	\$7.00	1.00	\$7.00		\$7.00		
Heavy	Medium	Drive	A	Light	5	5	\$3.00	\$2.00	\$5.00	0.00	\$0.00			
		Drive	A	Medium	5	10	\$3.00	\$3.00	\$6.00	0.20	\$1.20		\$10.80	
		Drive	A	Heavy	5	40	\$3.00	\$9.00	\$12.00	0.80	\$9.60			
		Drive	B	Light	5	10	\$3.00	\$3.00	\$6.00	0.10	\$0.60			
		Drive	B	Medium	5	20	\$3.00	\$5.00	\$8.00	0.80	\$6.40		\$8.20	
		Drive	B	Heavy	5	40	\$3.00	\$9.00	\$12.00	0.10	\$1.20			
		Train		5	20	\$2.00	\$5.00	\$7.00	1.00	\$7.00		\$7.00		
Heavy	Heavy	Drive	A	Light	5	5	\$3.00	\$2.00	\$5.00	0.00	\$0.00			
		Drive	A	Medium	5	10	\$3.00	\$3.00	\$6.00	0.20	\$1.20		\$10.80	
		Drive	A	Heavy	5	40	\$3.00	\$9.00	\$12.00	0.80	\$9.60			
		Drive	B	Light	5	10	\$3.00	\$3.00	\$6.00	0.00	\$0.00			
		Drive	B	Medium	5	20	\$3.00	\$5.00	\$8.00	0.15	\$1.20		\$11.40	
		Drive	B	Heavy	5	40	\$3.00	\$9.00	\$12.00	0.85	\$10.20			
		Train		5	20	\$2.00	\$5.00	\$7.00	1.00	\$7.00		\$7.00		

